SELF LOCKING APPARATUS

TECHNICAL FIELD

[0001] The presently disclosed apparatus relates to a self locking apparatus.

BACKGROUND OF THE INVENTION

[0002] Self locking apparatuses that can be positioned through a continuum of locations may be utilized in many applications. Some of these applications may fall into what might be described as temporary structures with telescoping elements. Among these are jack stands, extendable tripods, and canopies with telescoping legs.

[0003] If, in addition, such a self locking apparatus will stroke and absorb energy in a controlled fashion, if the loading on the self locking apparatus exceeds a design threshold, then such self locking apparatuses may find use in a number of automotive applications. These automotive applications include, but are not limited to: (1) an extendable/retractable bumper used to increase an automobile's energy absorbing space; (2) an extendable/retractable knee bolster used to help restrain vehicle occupants and absorb their kinetic energy during a rapid deceleration; and (3) a seatbelt pretensioner/load-limiter where a stroking distance is used to limit load and absorb energy. Accordingly, manufacturers continue to seek improved self locking apparatuses for a variety of reasons.

SUMMARY OF THE INVENTION

[0004] The disclosed apparatus relates to a self locking apparatus comprising: a housing; a load initiating element located within the housing; a spring located adjacent to the load initiating element, and configured to expand in compression against the housing; and wherein the load initiating element and spring are slideable within the housing until the spring is loaded into a self locking mode.

[0005] The disclosed apparatus also relates to a self locking apparatus comprising: an outer tube; an inner tube located within the outer tube; a load initiating element located within the outer tube and around a portion of the inner tube; a spring located adjacent to the load initiating element and around a portion of the inner tube and configured to expand in compression against the inner tube; and the load initiating element, spring and outer tube are slideable about the inner tube until the spring is loaded into a self locking mode.

[0006] In addition, the disclosed apparatus relates to a self locking apparatus comprising: an outer tube; a cylindrical body, with a plurality of slotted surfaces forming a plurality of load transfer segments, and with a bottom annulus, the cylindrical body located within the outer tube; a spring located adjacent to the bottom annulus and configured to expand in compression against the load transfer segments; and the slotted cylindrical body and spring are slideable within the outer tube in the absence of the spring being loaded into a self locking mode.

[0007] Additionally, the disclosed apparatus relates to a self locking apparatus comprising: an inner tube; a cylindrical body, with a plurality of slotted surfaces forming a plurality of load transfer segments, and with a bottom annulus, the cylindrical body located adjacent to an inner tube; a spring located adjacent to the bottom annulus and configured to expand in compression against the load transfer segments; and the inner tube is slideable with respect to the slotted cylindrical body and spring in the absence of the spring being loaded into a self locking mode.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] Referring now to the figures, which are exemplary embodiments, and wherein like elements are numbered alike:

[0009] Figure 1 is a top sectional view of one embodiment of a self locking apparatus;

[0010] Figure 2 is top sectional view of the self locking apparatus from Figure 1 with the inner tube axially moved towards the left;

[0011] Figure 3 is a top view of an outwardly biased conic spring;

[0012] Figure 4 is a cross-sectional side view of the conic spring from Figure 3;

[0013] Figure 5 is a top view of an inwardly biased conic spring;

[0014] Figure 6 is a cross-sectional side view of the conic spring from Figure 5;

[0015] Figure 7 is a top sectional view of one embodiment of a self locking apparatus with a conic spring;

[0016] Figure 8 is top sectional view of another embodiment of the self locking apparatus with a conic spring from Figure 7 with the inner tube axially moved towards the left;

[0017] Figure 9 is a top sectional view of self locking apparatus with an initiator wave spring and multiple additional wave springs.

[0018] Figure 10 is a top sectional view of the self locking apparatus of Figure 9, with the wave springs in a compressed state;

[0019] Figure 11 is a top sectional view of one embodiment of the self locking apparatus with an initiator conic spring and intermediate load conic springs and primary load conic springs;

[0020] Figure 12 is a top sectional view of the self locking apparatus of Figure 11, with the conic springs in a compressed state;

[0021] Figure 13 is a top sectional view of one embodiment of a self locking apparatus with wave springs and a load transfer spring;

[0022] Figure 14 is a top sectional view of one embodiment of the self locking apparatus with conic springs and a load transfer spring;

[0023] Figure 15 is a top sectional view of one embodiment of the self locking apparatus with inwardly biased conic springs;

[0024] Figure 16 is a perspective sectional view of one embodiment of a load transfer element for use in self locking apparatuses;

[0025] Figure 17 is a top sectional view of an embodiment of the load transfer embodiment in a self locking apparatus; and

[0026] Figure 18 is a top sectional view of an inertial loading embodiment of a self locking apparatus.

DESCRIPTION OF THE PREFERRED EMBODIMENT

[0027] Referring to Figure 1, a top sectional view of one embodiment 8 of a self locking apparatus is shown. A housing 10 is shown with a load initiating element 14 located within the housing 10. The housing may be a tube. The load initiating element 14 may be a friction element. A friction element may include o-rings, piston rings, or any devices that will provide an axial frictional force acting between the load initiating element 14 and the inner surface of the housing 10. An inner tube 18 is shown located within the housing 10. Positioned between the inner tube 18 and the load initiating element 14 is a wave spring 22. Although a wave spring is shown here, any spring that expands upon compression may be used, including, but not limited to a conic spring. Figure 2 is a top sectional view of the embodiment 8 of the self locking apparatus from Figure 1 with the inner tube 18 axially moved towards the left. As the inner tube moves to the left, the wave spring 22 is compressed between the load initiating element 14 and the inner tube 18. A wave spring when compressed will expand radially outward. Thus, if one or more wave springs are installed in a tube 10 with minimal radial clearance and compressed, expansion will occur and radial loading will result between the outer circumference of the wave spring 22 and the inner surface of the enclosing housing 10. With proper selection of wave spring and tubing stiffness, the friction resulting from the interference between the wave spring 22 and the housing 10 wall can be significantly greater than the axial loading necessary to initially compress the wave spring 22. When the friction resulting from

the interference between the wave spring 22 and the housing 10 is significantly greater than the axial loading, then the self locking apparatus is in a self locking mode.

[0028] In one non-limiting embodiment of the self locking apparatus shown in Figures 1 and 2, the wave spring 22 may have three waves, an inner diameter of about 9.0 mm, an outer diameter of about 12.5 mm, a height of about 0.9 mm, a thickness of about 0.18 mm, and a nominal deflection of about 0.3 mm at a load of about 24 Newtons. The housing 10 may be a tube with an inner diameter of about 12.58 mm, a radial tube thickness of about 2.0 mm, and a friction of coefficient of about 0.57 for steel on steel. With the above specified wave spring installed in the above specified tube, if the spring is compressed with a load of about 40 Newtons, the resulting radial load between the spring and tube would be about 280 Newtons, with a frictional load of about 160 Newtons. With the resisting load being greater than the applied load, the spring would not move within the tube, thus it would be in a self locking mode. With the use of a stack of six such wave springs, a load resistance of approximately 1000 Newtons would be obtained. Alternate dimensions and loadings may be employed for alternative designs.

[0029] The disclosed self locking apparatus is not limited to a wave spring for providing the radial expansion. A conic spring, also known as a Belleville washer, when axially compressed will expand both radially outward and inward. Figure 3 shows a top view of a conic spring 26 with a plurality of slots 30 located near the outer edge of the conic spring 26. Figure 4 shows a cross-sectional side view of the conic spring 26. By introducing slots 30 near the outer edge of the conic spring 26, one can bias the expansion in a radially outward direction. Figure 5 shows a conic spring 34 with a plurality of slots 38 located near the inner edge of the conic spring 34. By introducing slots 38 near the inner edge, one can bias the expansion in a radially inward direction. Figure 6 shows a cross-sectional side view of the conic spring 34. Figures 7 and 8 show how a conic spring can be arranged in a similar arrangement as the wave spring shown in Figures 1 and 2. In Figure 8, the conic spring 26 expands in compression and creates a frictional force between the conic

spring 26 and the inner surface of the housing 10, which locks the inner tube 18, conic spring 26 and load initiating element 14 in place relative to the housing 10.

[0030] Figure 9 shows a top sectional view of another embodiment 40 of the disclosed apparatus where the load initiating element 14 enables compression of an initiator wave spring 42. Additional wave springs 22 may be added to increase the friction area and axial load bearing capability of the embodiment 40 of the self locking apparatus. Also, by adding some additional hardware such as a pin 46 that is fixedly coupled to the inner tube 18 and is slideably coupled to a piston 50 such that when a force pulls the piston to the left, and the piston is restrained by the pin 46, then the pin 46 and piston 50 are not sliding with respect to each other, but when the piston 50 is pushed to the right, the pin 46 may slide into the piston 50. By pushing or pulling the piston to the right or to the left, one can position the load initiating element 14, pin 46, wave springs 22, 42 and the inner tube 18 in the housing. Additionally, if one moves the inner tube 18 to the right, the load initiating element 14, pin 46, and wave springs 22, 42 may also be re-positioned within the housing 10. However, if the inner tube 18 is moved to the left, the initiator wave spring 42 expands in compression and creates a frictional force between the initiator wave spring 42 and the inner surface of the housing 10 as shown in Figure 10. As the axial force of the inner tube increases, the other wave springs 22 expand in compression, which locks the inner tube 18, wave springs 22 and 42 and load initiating element 14 in place relative to the housing 10, thus putting the apparatuses in a self locking mode.

[0031] Figures 11 and 12 show a similar embodiment to the one shown in Figures 9 and 10, but with conic springs used instead of wave springs. An initiator conic spring 54, intermediate load conic springs 58 and primary load conic springs 62 are used with separators 66 separating the types of springs. The separators 66 may be washers, very stiff wave springs, or any other device that will separate the initiator conic spring 54, intermediate conic spring 58 and primary conic springs 62. The primary load springs 62, as a group, are stiffer than the intermediate load springs 58, which in turn are stiffer than the initiator conic spring 54. Thus as the inner tube 18 is moved to the left, the initiator conic spring 54 expands in compression and creates a frictional force between the wave spring 54 and the inner surface of the housing 10.

As the axial force of the inner tube increases, the intermediate wave springs 58 expand in compression. As the axial force of the inner tube continues to increase, the primary wave springs 62 expand in compression. As the wave springs 54, 58, 62 compress and expand, they lock the inner tube 18, wave springs 54, 58, 62 and load initiating element 14 in place relative to the housing 10.

[0032] In Figure 13, another embodiment 70 of the disclosed apparatus is shown. In this embodiment, a load transfer spring 74 allows forces used to position the springs 42, 54, pin 46 and inner tube 18 within the housing 10 to bypass the initiator wave spring 42. This embodiment therefore avoids the situation where the initiator wave spring 42 is prematurely compressed from a force from a piston rod 78 used to move and position the springs 42, 54, pin 46 and inner tube 18 within the housing 10. Thus, if the piston rod 78 is used to position the springs 42, 54, pin 46 and inner tube 18 within the housing 10 by moving the embodiment to the right, the moving force will travel from the piston rod 78, through the load transfer spring 74 through a piston head 82, through the pin 46 to the inner tube 18, thereby bypassing the wave springs 42, 22.

[0033] Figure 14 shows a similar arrangement to that shown in Figure 13, but with conic springs 54, 58 and 62 instead of wave springs.

[0034] Figure 15 shows another embodiment 86 of the self locking apparatus, but this embodiment 86 uses conic springs that have been biased for inward expansion, like the conic spring 34 shown in Figure 6. With this type of spring, one can create a resisting force between the internal circumference of the springs 90, 94 and the outside circumference of an inner tube 18 passing through the center of the springs 90, 94. Similar to the other embodiments, a load initiating element 14 provides the resistance necessary to compress the initiator internally biased conic spring 90 that, in turn, supplies sufficient resistance to compress the next stage of internally biased springs 94. In Figure 15, only two stages of springs 94 are shown, but a person skilled in the art would recognize that one may incorporate as many spring stages as are necessary to handle a specified design load.

[0035] All shown and previously discussed embodiments have used the interface friction directly between spring elements and a housing 10. Referring now to Figure 16, a load transfer element 96 embodiment is shown which would be used as an intermediate element between the spring and the housing surface. This would enable the independent optimization of the spring characteristics and the interface friction characteristics. One possible form of this intermediate element would be a cylindrical body 98 with a bottom annulus 102 against which the spring elements (not shown) would be positioned, and multiple vertical cuts in the cylindrical side wall to form load transfer segments 106 which can transfer the force from the expansion of the spring elements to an outer tube (not shown) that encloses the cylinder 98. The friction force between the outer surfaces of the load transfer segments 106 and the inner surface of an outer tube would lock the embodiment 96 in place with respect the outer tube. This embodiment may be configured such that the cylindrical body locks by inwardly applying a radial force on an inner tube which the cylindrical body fits around. This would be accomplished by having an inwardly biased conic spring adjacent to a annular surface that is on the outside of the cylindrical body.

[0036] Figure 17 shows a self locking apparatus using an embodiment of the load transfer element 96. A spacer washer 110 is located between the initiator conic spring 54 and the load transfer element 96, and the load transfer element is located between the washer 110 and the piston 50. The load transfer element 96 allows for the efficient load transfer from the wave springs 22, 54 to the outer tube. The spacer washer 110 is used to locate the initiator wave spring 54 in a radially compliant region of the load transfer element 96. In another embodiment, the load transfer element bottom annulus 102 may have a single radial cut to enable more radial load transfer near the bottom annulus 102.

[0037] Figure 18 shows an inertial loading embodiment 114 of a self locking apparatus. At least one mass element 118, slideably attached to the pin 46, provides sufficient inertial load such that the initiator wave spring 54 compresses and locks when the inner tube 18 exceeds design acceleration threshold in the direction of the arrow. Numerous other means of creating the resistance necessary to initiate compression of a spring stack, such as a direct mechanical connection or a viscous

design to enable a velocity dependent actuation, are possible and will generally depend on the specific application.

[0038] The embodiments of the self locking apparatus disclosed in this document provide a simple and low cost means for self locking an apparatus within a housing. In addition, some embodiments also provide a simple and low cost means for positioning such an apparatus in a housing.

[0039] It will be appreciated that the use of first and second or other similar nomenclature for denoting similar items is not intended to specify or imply any particular order unless otherwise stated.

[0040] While the invention has been described with reference to exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiments disclosed for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.